MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

EEL1196 – INSTRUMENTATION & MEASUREMENT TECHNIQUES

(All Sections / Groups)

28 FEBRUARY 2017
2.30 P.M – 4.30 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 5 pages including cover page with 4 Questions only.
2. Attempt **ALL FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) **Figure Q1(a)** illustrates the general block diagram of a measurement system. Copy and complete the block diagram into your answer booklet. Briefly explain the function of each element shown in the diagram. [8 marks]

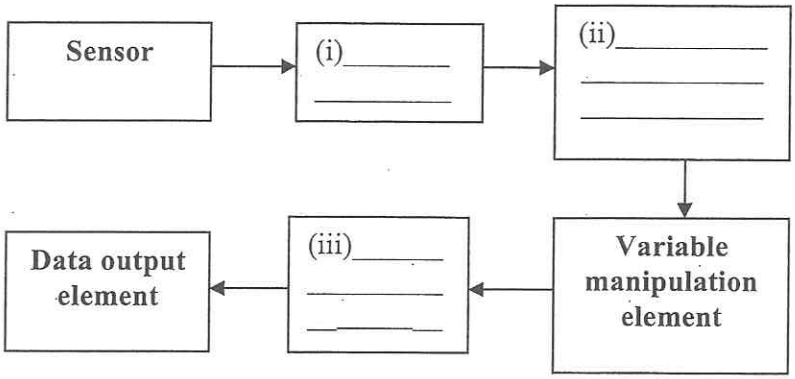

Figure Q1(a)

(b) In a resistor-capacitor (RC) circuit, the time constant, τ, is measured in seconds (s) and is given by the following formula:

$$\tau = RC$$

(i) If $R = 7\text{k}\Omega \pm 5\%$ and $C = 0.01\mu\text{F} \pm 3\%$, determine τ and its relative limiting error in percentage form. [5 marks]

(ii) If the same resistance R is used in a resistor-inductor (RL) circuit, where $\tau = \frac{L}{R}$ and $L = 1\text{mH} \pm 2.5\%$, determine τ and its relative limiting error in percentage form. [5 marks]

(iii) Prove that the dimension of τ is equal to T (time) by using any one of the two formulae given above. [3 marks]

(c) What is loading error? Discuss the impact of this error on measurement by citing a relevant example. [4 marks]

Continued...

Question 2

(a) A 150V moving-iron voltmeter takes a current of 150mA when it is connected to a $150V_{DC}$ supply. The coil has an impedance of $(1000+j75)\Omega$. Determine the percentage error in the reading when the meter is connected to a 150V, 50Hz AC supply, assuming that the voltmeter reads correctly at DC supply.

[4 marks]

(b) A PMMC (permanent magnet moving coil) type ammeter has 50-turns of moving coil with a width of 5cm and a depth of 2cm. The moving coil has a resistance of 50Ω and the working field is uniform and radial, of value 20mT.

(i) What are the torques, besides deflecting torque, that used to stabilize the pointer in order to give a correct reading on an indicating instrument?

[2 marks]

(ii) Calculate the deflecting torque produced on the coil when carrying a current of 15mA. [3 marks]

(iii) Based on part 2(b)(ii), estimate the resistance that must be connected in parallel with the coil in order to extend the ammeter up to 100FSD (full scale divisions) with 10mA/division. [4 marks]

(c) A magnetizing winding of 60-turns wound uniformly on an iron ring having a mean diameter of 0.1m and a cross-sectional area of $1cm^2$. A secondary winding of 20-turns is connected to a fluxmeter having a constant of 0.1×10^{-3}weber turn per division. When a current of 2A is reversed in the primary winding, a deflection of 33 divisions is observed. Determine:

(i) the applied magnetizing force, H. [4 marks]

(ii) the flux density, B. [3 marks]

(iii) total flux linkages in the iron ring, ϕ. [2 marks]

(iv) the relative permeability of the specimen, μ_r. [3 marks]

Continued...

Question 3

(a) The Current Balance Bridge is a type of DC Bridge, explain the method this bridge uses to null the bridge. [2 marks]

(b) The Current Balance Bridge shown in **Figure Q3(b)** has five fixed resistors, R_1=R_2=2kΩ, R_3=1kΩ, and R_4=800Ω and R_5=100Ω. Derive the expression and find the external current, I needed to balance this bridge. [8 marks]

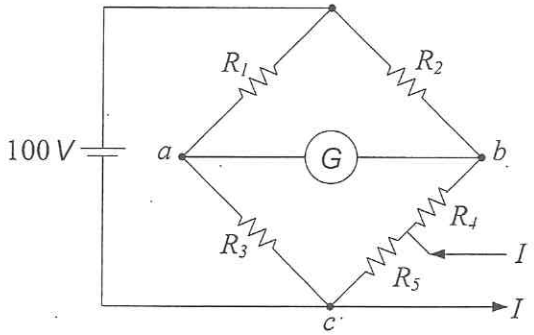

Figure Q3(b)

(c) A Series Resistance-Capacitance Bridge has two arms with resistor and capacitor placed in series, as shown in **Figure Q3(c)**.

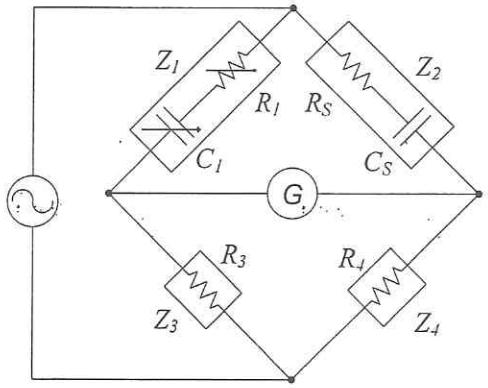

Figure Q3(c)

(i) Give the expressions of the impedances for each arm. [4 marks]

(ii) When the bridge is balanced, derive the expression for R_s, C_s and their dissipation factor, D. [6 marks]

(iii) The bridge is balanced at 100Hz, the values of the balancing components are $R_1 = 125\Omega, R_3 = 5k\Omega, R_4 = 8k\Omega$, $C_1 = 3.2\mu F$, calculate the values for R_s, C_s and their dissipation factor, D. [5 marks]

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Question 4

(a) A balanced 3-phase star connected loads draws 0.6A from a 3-phase, 50Hz power supply. The per-phase load impedance has a resistance of 500Ω and an inductance of 0.5H respectively.

(i) Draw a diagram showing how you can measure the total power using two wattmeters method. [3 marks]

(ii) Calculate the phase voltage and power factor. [4 marks]

(iii) Compute the total power absorbed by the 3-phase loads. [2 marks]

(b) An energy meter whose constant is 750rev/kWh makes N revolutions in 60s when it is connected to a load. Given that the load power is 50kW, determine the amount of revolutions, N has been made.

[3 marks]

(c) A strain gauge with gauge factor of 2.7 is attached to a structural member to measure strain. Initial resistance and final resistance of the gauge are 90Ω and 110Ω, respectively.

(i) Calculate the strain. [3 marks]

(ii) Describe the function, the construction and the principle operation of a strain gauge. [6 marks]

(iii) Explain **TWO (2)** effects of temperature on the strain gauge measurement. [4 marks]

End of Paper